ADVANCED GAS REBURN SYSTEM DEVELOPMENT and EXPERIENCE GREENIDGE STATION

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Abstract

Advanced Gas Reburning (AGR) is the synergistic integration of Gas Reburning (GR) and injection of a nitrogen agent to achieve enhanced NO_x emissions control. The Advanced Gas Reburning System installed at New York State Electric and Gas Corporation's Greenidge Station is the first full-scale demonstration of this technology. The goal of this project is to demonstrate a NO_x reduction capability approaching a conventional SCR process, but at lower capital and O&M cost.

The AGR System was installed at Greenidge Station's Unit #4, a 104 MW ABB-CE tangentially-fired boiler. The system was installed and tested in 1996, with substantial modifications to the system implemented in 1997. The 1997 modifications included new gas injectors to improve mixing for the AGR process, and modifications to the ammonia injection system. The improvements to the system were initiated to maximize AGR NO_x reductions and minimize ammonia slip.

Parametric testing was conducted during the 1997 ozone season, and additional testing is planned for the 1998 ozone season. The 1997 testing focused on evaluating the various AGR configurations installed at Greenidge, and improving the ammonia distribution and utilization. This paper presents the initial results of the 1997 test program and the success of the various AGR configurations.

Introduction

Greenidge Unit #4 is a 104 MW base-loaded, coal-fired unit located on Seneca Lake in upstate New York. New York State Electric and Gas (NYSEG) and Energy and Environmental Research Corporation (EER) collaborated on the installation of an AGR upgrade to the existing Gas Reburn System. The Advanced Gas Reburn R&D Project was selected for Greenidge in anticipation of Title I Phase II & III NO_x Regulations being imposed in Ozone Transport Region. This ratcheting of the allowable NO_x emissions increases the difficulty of planning and establishes flexibility as a critical component of any NO_x control strategy. Due to the inherent flexibility of the AGR system it was selected as an economical technology to meet future NO_x regulations at Greenidge.

AGR Technology

Advanced Gas Reburning (AGR) is the synergistic integration of Gas Reburning and Selective Non-Catalytic Reduction (SNCR). The AGR process combines the reburning process with SNCR technology to produce higher levels of NO_x removal. The Greenidge AGR system utilizes synergistic AGR where the reburn zone is operated near stoichiometric conditions, and the nitrogen agent and carrier air are injected simultaneously into the convection pass.

The Greenidge GR system consists of four gas injectors located in each corner of the furnace above the top burner elevation, and Over Fire Air (OFA) ports in each corner nine feet above the gas reburn injectors. The Greenidge AGR system consists of ammonia injection ports located on both side walls and in the middle of the boiler, and AGR booster fans which supply burn-out/carrier air to the side and middle injection ports.

Ammonia was used as the nitrogen agent, and is supplied to the plant as anhydrous then converted to an aqueous solution. The initial design of the ammonia system injected the ammonia into the burn-out/carrier air duct before the air/ammonia mixture was distributed to the injection ports, but this design limited the capability to bias the ammonia distribution and was ineffective in controlling ammonia slip. Prior to the 1997 testing the ammonia injection system was modified by installing twenty-two individual ammonia injectors with flow control devices at each injection port. The ammonia was injected into the carrier air and vaporized prior to entering the boiler.

1997 AGR Testing

The 1997 test program at Greenidge encompassed six specific series of tests including baseline, two gas reburn, and three AGR configurations. Each series of tests varied the stoichiometric ratios, gas flow, and other test specific variables. The baseline tests, conducted at three furnace zone stoichiometric ratios and varying distributions and quantities of OFA, established the uncontrolled NO_x level for evaluating the various NO_x reduction configurations.

Gas Reburn

Two series of gas reburn tests were conducted one with the originally designed gas injectors and one with EER's new high velocity gas injectors. The two test series varied the stoichiometric ratios, and the gas flow. The new gas injectors, which were installed to improve furnace mixing for the AGR process, also provided a slight improvement in NO_x reduction. The gas reburn system alone provides a 50% NO_x reduction.

Advanced Gas Reburn

Three configurations of AGR were tested during the 1997 test program, GR & SNCR, AGR/Rich and AGR/Lean.

The GR & SNCR series of tests involved gas reburn in series with Selective Non-Catalytic Reduction(SNCR). This approach is referred to as non-synergistic advanced reburn, and was critical in determining the effectiveness of the synergistic AGR configurations. The GR with SNCR provided no additional NO_X reduction and no NH_3 slip. This indicated that any additional NO_x reduction was offset by an equal amount of NO_x produced by the high temperature oxidation of ammonia.

The AGR/Rich configuration consisted of injecting ammonia with temporary lances inserted through observation doors in the front wall across from the furnace nose, and injecting all of the burnout air in the convection pass with the booster fans. This configuration attempted to minimize the oxygen above the reburn zone where the ammonia was being injected. The AGR/Rich configuration provided no additional NO_X reduction with no NH_3 slip. These results were the same as the GR & SNCR test, high temperature oxidation of the ammonia which increased NO_x formation, thereby offsetting the NO_x reduction.

The AGR/Lean configuration consisted of injecting ammonia into the carrier/burnout air in the convection pass. Extensive testing was undertaken with this configuration, varying the stoichiometric ratios, the gas flow, the ammonia stoichiometric ratios, and the ammonia distribution. The AGR/Lean configuration was successful in reducing NO_x emissions 20% below that achievable with Gas Reburn alone. The modified ammonia injection system was successful in controlling reagent distribution and therefore ammonia slip.

Conclusions

The AGR Technology at Greenidge has been successful in reducing NO_x emissions beyond that achievable with Gas Reburn alone. Additional optimization testing is planned for 1998, with long term testing to follow. The AGR system at Greenidge provides the plant with a flexible NO_x reduction system with a broad range of NO_x reduction capability.